Protocol Development Summary

NETN protocol: Phenology

NETN parks where protocol will be implemented:
Acadia NP (ACAD), Appalachian NST (APPA), Marsh-Billings-Rockefeller NHP (MABI), Morristown NHP (MORR), Saratoga NHP (SARA)

Justification/issues being addressed:
Climate change is projected to disproportionately stress temperate ecological systems over the next century and beyond. Notably, the northeastern United States, where NETN is located, has seen greater warming over the last century than most other regions of the country. A growing body of evidence indicates that climate change has already altered phenological patterns of a wide variety of organisms including terrestrial plants, birds, amphibians, insects, and aquatic algae (Parmesan and Yohe 2003, Root et al. 2003). These altered phenological patterns may have far-reaching consequences. Research shows that responses to climate change will vary among species within an ecosystem; thus responses to climate change such as altered timing of budbreak, migration or reproduction may alter competitive interactions and uncouple food webs and mutualistic relationships. For example, changing climate and phenology may alter competitive or parasitic interactions between native and invasive exotic species, such as between native trees and insect pests. Recent observations indicate that phenological events occurring in early spring have been most responsive to changing climate (Walther 2004), that phenology of herbaceous species has been more responsive to changing climate than that of woody species, and that insect-pollinated species are more responsive than wind-pollinated species. There is some evidence that phenology may be a major factor determining the range of tree species (Chuine and Beaubien 2001).

This protocol addresses the Phenology Vital Sign and will draw upon data collected as part of the Climate Vital Sign. By monitoring phenological indicators in addition to temperature, NETN will gain insight into the early impacts of climate change on functioning ecosystems – how different species may respond differently to climate change and how these differences may alter ecological relationships and perhaps ecosystem function. While the opportunity for NPS to undertake adaptive management based on data from phenological indicators is more limited than that from many other vital signs selected by NETN, there are several reasons NETN has chosen to include them. First, climate change is likely to be one of the most significant forces of change acting upon temperate ecosystems over the long-term. Second, the Appalachian Trail spans the dramatic latitudinal and elevational gradients of the eastern United States, and thus provides an unusual opportunity to monitor the effects of changing climate along these gradients. Third, phenological data from the National Parks documenting ecosystem change may contribute to national policy-making on global change. And fourth, phenological data can effectively be collected by citizen volunteers, which provides useful educational and outreach benefits.

Specific monitoring questions and objectives to be addressed by the protocol:
Our overall goal is to monitor the status and trends of NETN ecological resources in order to assess ecological integrity and the impacts of key agents of change acting upon these resources,

and to inform management decisions affecting these resources. The specific objectives of this protocol are to: 1) Establish long-term transects along elevational and altitudinal gradients of the Appalachian Trail and across selected NETN parks; 2) Monitor long-term trends in phenology of selected focal taxa and habitats, particularly focusing on populations occurring near the edge of species' ranges; 3) Monitor long-term trends in phenology of key invasive exotic species likely to benefit from climate change; and 4) Compare and contrast current measurements to historical records and modeling efforts, in order to assess the magnitude of phenological change.

Specific monitoring questions this protocol may address are:

What are long-term trends in leaf-out dates and growing season length for selected tree species?

What are long-term trends in flowering dates for selected herbaceous species?

What are long-term trends in spring arrival dates for selected bird species?

What are long-term trends in spring calling dates for selected frog species?

What are long-term trends in spring emergence for selected butterfly and other insect species?

What are long-term trends in flowering phenology of key invasive exotic plant species? What are long-term trends in emergence phenology of key invasive exotic insect pest species?

What are long-term trends in ice-out dates on lakes across the NETN region?

How do aggregate trends in these phenological indicators compare to current temperature data and to historical records?

Basic approach:

NETN plans to implement a rapid assay approach which can incorporate significant contributions from citizen volunteers. We will draw upon protocols and standards of the European phenology network, the GLOBE program, and the Long-Term Ecological Research (LTER) program. During protocol development, we will select specific measures for implementation at specific NETN parks. These measures may include tree leaf-out date, herb flowering date, bird spring arrival date, frog spring calling date, butterfly and/or insect emergence date, all for selected species, and/or lake ice-out date. NETN may choose to synthesize or coordinate with ongoing phenology monitoring underway by other organizations. Within this monitoring program, NETN plans to include specific invasive exotic plant and insect species that may benefit from changing climate.

Principal investigators and NPS lead:
This protocol will be developed by SUNY ESF under a cooperative agreement with PI James Gibbs and Geri Tierney, and with PI Don Faber-Langendoen of NatureServe. NETN network coordinator Brian Mitchell is the NPS lead.

Development schedule, budget, and expected interim products:
Protocol development will begin in September 2005, draft protocols will be submitted by June 15, 2006. Field testing of these draft protocols will occur during the 2006 field season, and updated SOPs will be submitted by September 30, 2006.

The budget for development of this protocol is estimated to be $10,000 in 2005 and $10,000 in 2006, which includes partial salary for a SUNY post-doctoral associate responsible for drafting SOPs, and costs for field testing draft protocols.

Literature cited:
Chuine, I and EG Beaubien. 2001. Phenology is a major determinant of tree species range. Ecology Letters 4 (5): 500-510.

Fitter, AH and RSR Fitter. 2002. Rapid changes in flowering time in British plants. Science 296 (5573): 1689-1691.

Parmesan, C and G Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421 (6918): 37-42.

Root, TL, JT Price, KR Hall, SH Schneider, C Rosenzweig, and JA Pounds. 2003. Fingerprints of global warming on wild animals and plants. Nature 421 (6918): 57-60.

Walther, GR. 2004. Plants in a warmer world. Perspectives in plant ecology evolution and systematics 6 (3): 169-185